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Engineering & sciences applied to the earth & its environment

February 14, 1997

Mr. Jon Peterson
U.S. EPA - Region V
Waste Management Division
77 W. Jackson Blvd.
Chicago, IL 60604

Subject: Response to Preliminary Design Issues
Albion-Sheridan Township Landfill
Albion, Michigan
Project No. 6E13045

Dear Mr. Peterson:

Woodward-Clyde Consultants (WCC) is submitting this letter in response to the technical issues associated with the Preliminary (30%) Design for the Albion-Sheridan Township Landfill (ASTL). The issues described below were discussed during the February 4, 1997 meeting between Cooper Industries and Corning, Inc. (The Group), the United States Environmental Protection Agency (U.S. EPA), the Michigan Department of Environmental Quality (MDEQ), the U.S. EPA's contractor (Earth Tech) and WCC.

Technical issues raised include the following:

1. Additional information was requested to evaluate the proposed technical equivalent to the cover system drain layer as allowed by the Record of Decision (ROD).
2. The drain layer technical equivalent incorporated the use of on-site soils and a synthetic strip drain configuration. The spacing criteria and basis for the strip drains in the cover system was not clearly supported in the 30% Design Document.
3. The risers on the horizontal passive gas vent wells should be extended to 6 feet above the landfill surface to prevent clogging with snow in the winter.
4. The location of the 2% minimum slope indicators for the flow channels shown on Drawing 5 make it unclear as to whether the 2% minimum applies to landfill slopes in that area or the berm cross slope.
5. There was concern over the location of the stormwater infiltration basin currently sited on the north and east sides of the landfill. The concern focused on creating

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more infiltration on the upgradient side of the landfill which could potentially increase mobilization of contaminants/downgradient contamination.

Upon review and evaluation of the issues of concern, WCC offers the following responses.

Response to Technical Issues 1 and 2

WCC has proposed a technical equivalent for the drain layer component of the cover system at ASTL. The ROD indicates that the drainage layer will be composed of six-inches of sand with a minimum hydraulic conductivity of $1x10^{-2}$ cm/sec or a synthetic material with a minimum transitivity of $3x10^{-5}$ m^2/sec. MDEQ has indicated in the February 4th meeting that a drainage layer with a minimum hydraulic conductivity of $1x10^{-3}$ cm/sec would be acceptable; Michigan rules do not require a minimum transmissivity or hydraulic conductivity. WCC has proposed that on-site soils with an estimated hydraulic conductivity of $1x10^{-4}$ cm/sec, augmented with synthetic strip drains be used for the drain layer. The strip drains are 12 inches wide by one inch high wrapped in a filter fabric. The strip drains would be place on top of the flexible membrane liner (FML) and spaced at 20 foot intervals perpendicular to the slope as shown in Drawing 6 of the 30% Design Document. The strip drains have a transmissitivity of $1.5x10^{-4}$ m^2/sec.

The other design consideration in evaluating the drain layer performance is slope stability. Saturated soil depth above the FML is the main concern when addressing the stability of cover materials on landfill slopes and that is one reason why subsurface drainage needs to be provided for in the design. The following discussion supports the technical adequacy of the proposed drainage configuration in controlling the saturated soil depth over the FML.

The HELP Model was utilized to estimate stormwater infiltration and subsequent depth of saturated soils over the FML during storm events. The HELP Model estimated less than a two inch maximum average saturated soil depth across the FML for 30 day periods (monthly) for the cover system with cover soils with a hydraulic conductivity of $1X10^{-4}$ cm/sec without stripdrain. In orderto acquire data useful for design, peak daily results were used as described below.

A HELP Model was performed for the proposed design cover section which was layered as follows: six inch topsoil, 24 inch cover soil ($K = 1x10^{-4}$ cm/s), 40 mil LLDPE. The results of the analysis were used to generate an inflow (infiltration) rate for the peak daily event for years 1 through 25. The inflow was calculated by taking the 24 hour precipitation amount and subtracting the runoff. This provided a depth of inflow per 24 hour period; that inflow was then converted to units of centimeters per second in order to be compatible with the second stage of calculations.

Calculations were then performed to estimate the depth of saturated soils (saturated Cover depth over the FML) between the 12 inch wide strip drains. The model used for this phase of the equivalency analyses is based on accepted methods for a similar calculation of leachate head on a liner system to determine spacing of collection piping (see attachment). It is WCC's judgment that this model was applicable, as the cover system section closely resembles the leachate system as both situations have open flow channels separated by a granular medium. A conservative case, assuming no cross gradient, was used for this model. Input for the calculations included an inflow rate (obtained from the HELP Model), hydraulic conductivity of the soil medium separating the strip drains and the strip drain spacing. The results (attached) indicate a peak daily saturated cover depth of 20.4 inches for a 20 foot strip drain spacing, substantially less than peak daily saturated cover depths for the cover system utilizing a six inch sand drainage layer ($K = 1x10^{-3}$ cm/s).

WCC concludes the proposed cover system utilizing the on-site soils ($K=1x10^{-4}$ cm/s) in conjunction with the 12 inch wide strip drains spaced 20 feet apart exceeds the subsurface drainage requirements for slope stability of the landfill cover system. The factor of safety to an increased inflow is the additional 9 to 10 inches of distance from the modeled height of saturated cover materials (20.4 inches total height) to the surface of the cover system (30 inches total height). This conclusion is based on the HELP Model run performed for the proposed design cover system and the saturated cover depth calculations supporting the spacing of the strip drains and their effect on the saturated cover depth.

Response to Technical Issue 3

WCC will redesign the vent well risers on the horizontal passive gas vent wells to extend six feet above the landfill surface.

Response to Technical Issue 4

The surface water flow channels along the road and berms are a minimum of two percent and maximum four percent. The landfill cover grades are a minimum of four percent and maximum of 25 percent. This will be clarified in the drawings.

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Response to Technical Issue 5

A cross-section (attached) adapted from Figure 28 of the Final Remedial Investigation Report ((RI) WWES, April, 1994) indicates the relationship of the infiltration basin to the waste on the north end of the landfill. Based on the Soil Conservation Service TR-55 watershed model calculations for a 100 year, 24 hour event (5.00 inches of precipitation), approximately 3.0 acre feet of storage is required for the precipitation and runoff from the areas contributing to the 3.3 acre infiltration basin, which results in less than 12 inches of water to infiltrate in the basin. Results of the RI indicate an average (high and low thrown out) hydraulic conductivity of 6.89×10^{-3} in the unconsolidated sediments which are generally described as fine to coarse sand. The time required to infiltrate the peak amount of stormwater runoff from the maximum design storm (12 inches), assuming a hydraulic conductivity consistent with the RI (6.89×10^{-3}), is approximately 1.5 hours.

As you are aware, WCC is pursuing other property options for stormwater control and infiltration and will keep you apprised of the progress. If you have any questions regarding this information, do not hesitate to contact me at (612)593-5650.

Sincerely,

Dean Stockwell
for
Robert G. Gibson
Project Manager

Stacy E Hozuka
for John Seymour, P.E.
Project Coordinator

RGG:rgg

cc: Elizabeth Bartz - EARTHTECH
Kim Sakowski - MDEQ
Chistopher Smith - Cooper Industries
Jack Gray - Corning, Inc.
File

WOODWARD-CLYDE CONSULTANTS
LANDFILL DESIGN

Project Name: Albion-Sheridan Landfill
By: Robb Johnson
Checked By: Bob Gibson

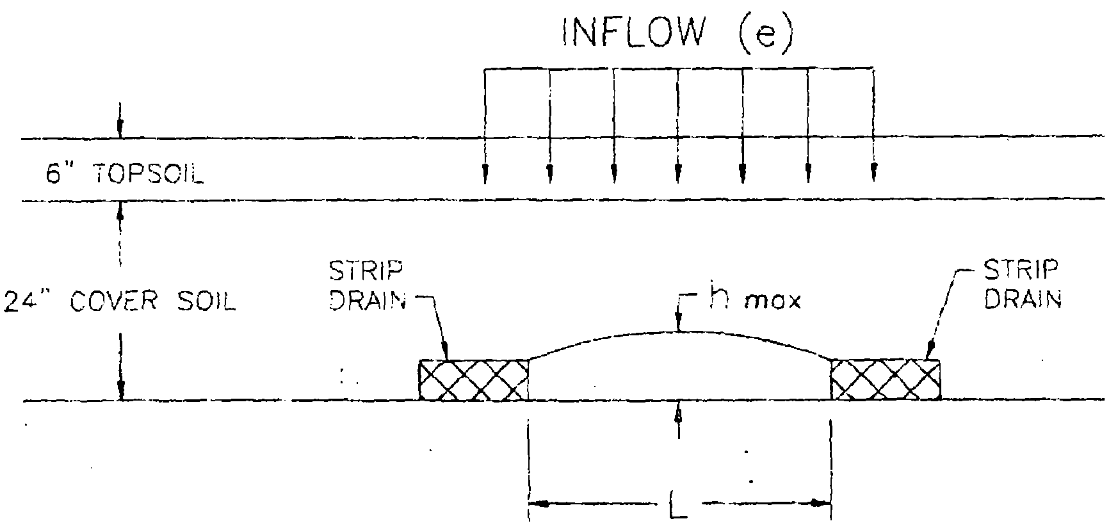
W-C Project Number: 6E13045
Date: February 7, 1997
Date: February 7, 1997

Determination of Saturated Cover Depth Due to Stormwater Inflow

The saturated cover depth above the collection system may be determined by a simple model. In the model developed by Oweis and Khera using Darcy's equation, the maximum height of fluid between two parallel drainage channels is a function of amount of stormwater infiltration, distance between the collection channels and the slope of the barrier layer toward the collection channels. This principle is used in determining leachate collection pipe spacing and can also be applied to strip drains utilized in a landfill cover system for subsurface stormwater drainage. The difference between the two applications of this theory is that the slope toward the collection channel that is a factor for the determination of the leachate head in a liner application does not exist when applying the principle to the strip drains in a landfill cover system as there is not a cross-slope toward the channel.

The maximum saturated cover depth, h_{max} is conservatively computed as:

$$h_{max} = (L/2)[(i^2 + e/k)^{1/2} - i]$$



Coefficients as follows:

$i := 0.00 \cdot \frac{ft}{ft}$	Slope of barrier layer toward collection channel (not applicable)
$e := .0000029 \cdot \frac{cm}{sec}$	Inflow rate (From HELP Model -- Peak Daily Precipitation minus Runoff)
$k := 1 \cdot 10^{-4} \cdot \frac{cm}{sec}$	Permeability of the cover soil layer
$L := 20 \cdot ft$	Strip drain spacing (flow channel spacing)
$h_{max} := \left(\frac{L}{2}\right) \cdot \left(\sqrt{i^2 + \frac{e}{k}} - i\right)$	Maximum saturated cover depth allowable above the FML
$h_{max} = 1.7 \cdot ft$	If h_{max} is less than the depth of the landfill cover above the FML, then the design is acceptable, if not, then redesign the stripdrain spacing

References: Oweis, I.S.and R.P. Khera, "Geotechnology of Waste Management," Butterworths,
USEPA, "Draft Technical Manual for Solid Waste Disposal Facility Criteria," 40 CFR Part 258, April, 1992
Linsey, R. K. and J. B. Franzini, "Water-Resourses Engineering, McGraw-Hill, 1979

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                 **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**              USAE WATERWAYS EXPERIMENT STATION                           **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\ASTL1.D4
TEMPERATURE DATA FILE:        C:\HELP3\ASTL1.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\ASTL1.D13
 VAPOTRANSPIRATION DATA:      C:\HELP3\ASTL1.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\ASTL3.D10
OUTPUT DATA FILE:             C:\HELP3\ASTL3.OUT


TIME: 17:20     DATE:   2/ 6/1997


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     TITLE:  ALBION-SHERIDAN TOWNSHIP LANDFILL -- COVER SOIL LAYER

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
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                     TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
          THICKNESS                   =        6.00   INCHES
          POROSITY                    =      0.4530 VOL/VOL
          FIELD CAPACITY              =      0.1900 VOL/VOL
          WILTING POINT               =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.3380 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3711	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC
SLOPE	=	4.00	PERCENT
DRAINAGE LENGTH	=	200.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

THICKNESS	=	0.00	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.399999993000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.75	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	70.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.414	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.394	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.758	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	10.934	INCHES
TOTAL INITIAL WATER	=	10.934	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
E. LANSING MICHIGAN

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	123
END OF GROWING SEASON (JULIAN DATE)	=	283
AVERAGE ANNUAL WIND SPEED	=	10.10 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	77.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	80.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.60	23.30	33.00	46.30	57.20	66.80
70.80	69.20	61.70	50.70	38.50	27.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

STATION LATITUDE = 42.60 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						

TOTALS	1.81	1.73	2.32	3.26	3.07	3.40
	3.00	2.93	2.55	1.65	2.46	2.78
STD. DEVIATIONS	0.69	0.82	1.02	1.22	1.17	1.47
	1.23	1.73	1.36	1.11	1.06	1.06

RUNOFF

TOTALS	0.753	1.029	1.306	0.681	0.003	0.002
	0.001	0.003	0.000	0.000	0.006	0.331
STD. DEVIATIONS	0.910	0.846	1.023	0.897	0.016	0.009
	0.004	0.010	0.000	0.000	0.031	0.534

EVAPOTRANSPIRATION

TOTALS	0.483	0.530	1.507	2.856	3.160	4.434
	4.330	2.227	2.510	1.269	0.680	0.427
STD. DEVIATIONS	0.096	0.153	0.331	0.514	1.027	0.906
	1.192	0.919	0.659	0.464	0.149	0.079

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.0920	0.0773	0.0834	0.1252	0.1614	0.1482
	0.1152	0.1022	0.0984	0.0977	0.1037	0.1114
STD. DEVIATIONS	0.0126	0.0091	0.0126	0.0550	0.0547	0.0439
	0.0180	0.0127	0.0206	0.0210	0.0497	0.0358

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	0.0677	0.0573	0.0619	0.0826	0.1042	0.0979
	0.0816	0.0740	0.0711	0.0710	0.0718	0.0771
STD. DEVIATIONS	0.0080	0.0061	0.0082	0.0277	0.0266	0.0207
	0.0103	0.0073	0.0118	0.0122	0.0200	0.0177

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 3

AVERAGES	10.5645	9.8836	9.6044	13.9915	17.4930	16.9195
	13.2607	11.8254	11.7420	11.2834	11.8724	12.4241
STD. DEVIATIONS	1.4871	1.2321	1.4996	5.3283	4.9878	4.0225
	1.9230	1.3727	2.2765	2.2803	3.8606	3.3064

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 25

	INCHES		CU. FEET	PERCENT
PRECIPITATION	30.97	(3.587)	112415.3	100.00
RUNOFF	4.115	(1.8301)	14938.49	13.289
EVAPOTRANSPIRATION	24.414	(2.6029)	88621.25	78.834
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1.31621	(0.19566)	4777.829	4.25016
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.91830	(0.10392)	3333.443	2.96529
AVERAGE HEAD ACROSS TOP OF LAYER 3	12.572	(1.652)		
CHANGE IN WATER STORAGE	0.205	(2.6325)	744.28	0.662

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 25

	(INCHES)	(CU. FT.)
PRECIPITATION	2.92	10599.601
RUNOFF	2.821	10239.3682
DRAINAGE COLLECTED FROM LAYER 2	0.01426	51.74851
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.005370	19.49346
AVERAGE HEAD ACROSS LAYER 3	29.100	
SNOW WATER	4.12	14965.1523

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4632
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0873

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FINAL WATER STORAGE AT END OF YEAR 25

LAYER	(INCHES)	(VOL/VOL)
1	1.7430	0.2905
2	11.2534	0.4689
3	0.0000	0.0000
SNOW WATER	0.000	

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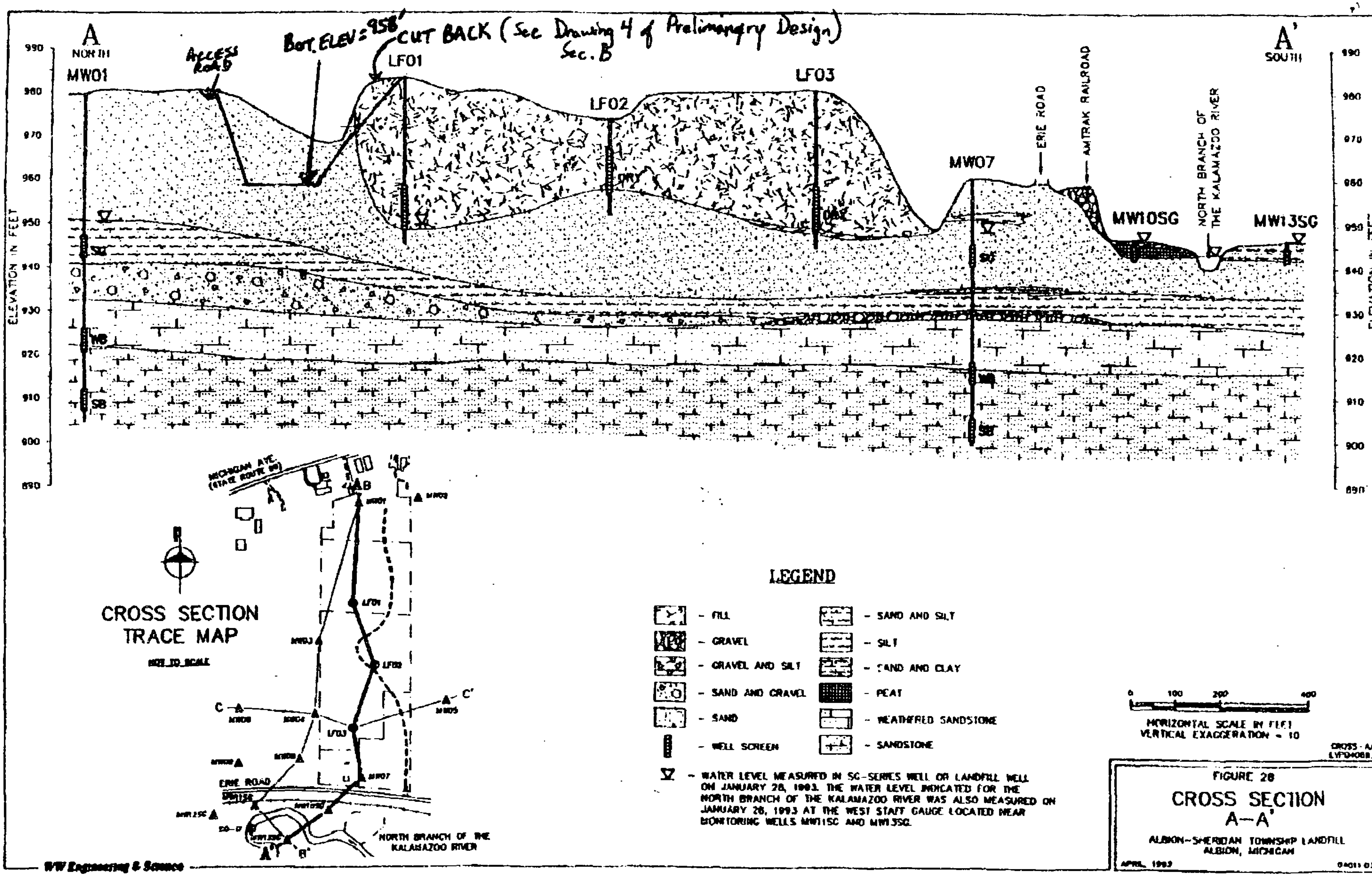

A
NORTH
A'
SOUTH
MW01
ACCESS ROAD
Bot. ELEV = 958'
CUT BACK (See Drawing 4 of Preliminary Design)
Sec. B
LF01
LF02
LF03
DRY
MW07
ERIE ROAD
AMTRAK RAILROAD
NORTH BRANCH OF THE KALAMAZOO RIVER
MW10SG
MW13SG
SG
WB
SB
ELEVATION IN FEET
990
980
970
960
950
940
930
920
910
900
890
CROSS SECTION TRACE MAP
NOT TO SCALE
MICHIGAN AVE. (STATE ROUTE 99)
ERIE ROAD
NORTH BRANCH OF THE KALAMAZOO RIVER
C
C'
B
B'
LEGEND
- FILL
- GRAVEL
- GRAVEL AND SILT
- SAND AND GRAVEL
- SAND
- WELL SCREEN
- SAND AND SILT
- SILT
- SAND AND CLAY
- PEAT
- WEATHERED SANDSTONE
- SANDSTONE
- WATER LEVEL MEASURED IN SG-SERIES WELL OR LANDFILL WELL ON JANUARY 28, 1993. THE WATER LEVEL INDICATED FOR THE NORTH BRANCH OF THE KALAMAZOO RIVER WAS ALSO MEASURED ON JANUARY 28, 1993 AT THE WEST STAFF GAUGE LOCATED NEAR MONITORING WELLS MW11SG AND MW13SG.
0
100
200
400
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 10
CROSS - AA
FIGURE 28
CROSS SECTION
A—A'
ALBION–SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN
APRIL, 1993
WW Engineering & Science